Expanding access to healthcare through Innovation

Foreword

“Chance favors the prepared mind, Opportunity favors the bold” said Louis Pasteur.

I like to think that **innovation** was on his mind when he said this. Innovating, which each and every one of us has a different definition of, is about gathering the elements of an imperfect storm. It’s about being **informed** and **knowledgeable**, therefore prepared. It’s about **taking risks**, **iterative risks**, **disruptive risks**, therefore being bold. And of course, it’s about being open to some form luck or chance, to imperfection in the process, 70/30, again, 80/20, again, and seizing the opportunity. Like seizing the little God Kairos who is constantly circling the earth with his long hair waiting to be caught. **It’s another notion of time, that complements Chronos, it’s about seizing the moment**.

The current **COVID pandemic** is truly a dark time the world is going through. But as the Chinese word for Crisis illustrates - **危机 wēi jī**, danger & a crucial tipping point – **a crisis is a schizophrenic moment**. In other words, this pandemic has created an **imperfect storm for health innovation**. It has given the entire world a crash course on Health, and another crash course on Digital mainstreaming. And even though no one had waited for the COVID virus to develop **Telehealth Services**, move the **Phygital Cursor** massively towards the digital side or use **Artificial Intelligence** to compete with doctor diagnoses, the current crisis did make us all press on the **accelerator**. AXA has moved to 3rd, 4th gear. It is scaling **access to healthcare**, to make sure **no one is left behind**, to **contribute to human progress**. It is ensuring our current and future clients are given **full transparency**, a **clear and simple care** journey, that **care coordination** is given as much importance as the diagnosis itself. It is investing in prevention and raising awareness to change behaviours, pivoting the role of an insurer from one that solely pays to repair, to one that holds hands and partners throughout the customer health journey.

Thanks to the collective expertise of our partners around the world, AXA Research Fund scholars, medical advisors, health experts from the public & private sectors, and the expertise of our own business leaders, I am very pleased to share this publication with you.

Sincerely,
Garance Wattez-Richard
CEO, AXA Emerging Customers

Introduction

Expanding access to healthcare is about rethinking what's possible. Through innovation, we can increase the resources available, use them more efficiently, and provide new ways of accessing healthcare. Scalability is key. Before, one doctor treated one patient, requiring a physical location to meet and the presence of both the doctor and patience. Today, patients can access healthcare professionals digitally, automation of many services is possible, and enhanced computing power can make best use of limited human resources.

Healthcare access can be expanded directly through changes in patient experience, as we will see through digital customer experiences, and changing the point of care experience through symptom checkers. Innovation in how people reach health services, and how time is spent when they are in touch with a medical provider, can be very effective in increasing access to care.

Innovation that goes beyond patient touchpoints is also changing healthcare access. Blockchain, a promising new way of sharing information, holds promise both for medicine and health insurance. US-based Decent Health Management offers insights on how blockchain can be a key enabler for making healthcare affordable, efficient, and trustworthy.

Artificial intelligence, particularly its machine learning branch, is changing many aspects of our lives with significant impacts on medicine. It is already expanding medical capacity through the use of computers to do work that previously only highly trained specialists could do. Through the work of AXA Research Fund Artificial Intelligence Chair, Thomas Lukasiewicz, will be even more widely applied to medicine. Machine learning has already proved its potential during the COVID-19 pandemic, with research from AXA Research Fund grantee Santiago Mazuelas being used to predict the severity of cases. Such research holds the promise of helping allocate healthcare resources to plan for the needs of local populations and thereby make healthcare more efficient and accessible.

Innovation is a key lever in expanding healthcare access. By changing how people access care, we can improve efficiency, affordability, and overcome logistical hurdles for reaching medical services. Going behind the scenes with blockchain and artificial intelligence, we can change the healthcare ecosystem and increase the capacity within health systems. The application of technological progress to medicine and insurance is critical for expanding healthcare access.

Point of care innovations: leveraging fully digital customer experiences and symptom checkers to expand healthcare access

Fully digital customer experience:

The digital transformation in accessing healthcare has only been accelerated by the COVID-19 pandemic. The use of telemedicine has exploded around the world, with the global telehealth market is expected grow from $83.08 billion in 2020 to $218.5 billion in 2025 at a CAGR of 28.34% [1]. It democratizes access to healthcare, removing many of the logistical complications of seeing a doctor, and tends to be less costly than in-person care for insureds, often being offered at low or no additional cost.

More than simply providing health services digitally, telehealth also gives tools to navigate the healthcare journey. For example, Oscar Health Insurance, a strategic partner of AXA, positions itself as a healthcare concierge that helps navigate the care journey. It has made virtual urgent and primary care (in certain markets) available without any additional fee or co-pay for its insureds, positioning itself as the point of entry to the healthcare system and helping them find doctors and specialists that are affordable within their plans and conveniently located.

[1] Report Linker - Telehealth Global Market Report 2021: COVID-19 Growth And Change
https://www.reportlinker.com/p06036653/Telehealth-Global-Market-Report-COVID-19-Growth-And-Change.html?utm_source=GNW - 2021

Acceleration of digital services: View from Maestro Health

Maestro Health is a tech-enabled third-party administrator (TPA) for employee health and benefits. It was acquired by AXA in 2018 and continues to be a leader in providing a seamless and fully digital experience for insureds. Their experience shows what a catalyst the pandemic has proven for digital health.

Many employers and health plans are continuing to invest in digital applications such as mobile apps, web portals and telehealth platforms to communicate health messages and conduct health services. More people are now comfortable video calling their doctor and using mobile apps in their daily lives, which is quickly translating into the health and benefits space. Having a digital-first approach to benefits is a way to not only reach individuals on the devices they use daily, but lower costs.

This increased focus on telehealth capabilities will impact how patients receive care and allow more doctors, healthcare providers, employers and individuals to see the benefits of telehealth as a continued offering. Phone calls, health-monitoring devices and video consultations enable us to receive care from the comfort of our own homes and take control of our own mental and physical well-being. Just like technology should be an enabler of better service not a replacement of a person, telemedicine is an enabler of better patient care not a replacement for a primary care physician/team or a specialist.

Access to good care has long been an issue for many Americans—and it's only getting more challenging as many wrestle with navigating new routines and managing their wellbeing in the midst of COVID-19.

Here are some ways to better direct people to the right care:

- Educate health plan members about where and how they can access care. Especially around when an emergency calls for seeking care at urgent care or a walk-in clinic vs when telehealth options are acceptable.
- Encourage members to "shop around" for care using the tools they likely already have available to them. Services like virtual second opinions and telehealth are often much more affordable ways to access quality care.
- Create a single source of truth for benefits information and market it to your health plan members year-round. Utilize online resources like a company intranet or benefits portal to make sure your people have access to and know where to find the latest info about their benefits.

Many people underestimate the number of care options available to them due to a lack of knowledge and understanding of today's healthcare system. In the same way that people usually don't shop around for the best healthcare price, they usually don't take the time to identify all of their provider options before receiving care. By educating and informing employees of their options, we can make smarter healthcare consumers.

Craig Maloney
CEO of Maestro Health

The team at Maestro Health recently surveyed more than 1,000 Americans about their experience with the U.S. healthcare system in our whitepaper "The Poor Health of America's Healthcare System." Seventy percent of those we surveyed feel that today's healthcare system is difficult to navigate—and the pandemic has really continued to confirm this.

The realistic optimist in me believes there is still time for us to get the healthcare experience right.

One of our opportunities lies in the fact that 36% of the people we surveyed said virtual access to their health providers improved their personal health journeys. And there's no time like the present (or a pandemic) for us to really dive deep into the telehealth waters.

Although the recent digitization of healthcare has been an epiphany for many in the industry, we cannot overlook the importance of a human interaction. Technology is a driver—not a replacement—for quality, human-driven healthcare.

Don't get me wrong—I think we should be inspired by the way technology continues to evolve healthcare. But the reality is, healthcare may never be completely digitized. The need for the human connection is still an important piece to the healthcare puzzle, even in the age of telehealth.

At Maestro Health, we're infusing a very human experience with best-in-class technology to help further members' connections with their health and their healthcare.

Take our in-house call center, for example. When most people hear the words 'call center,' the expectation is that the experience won't be good—calling in for help has traditionally been an unhelpful and frustrating experience.

We've set up our call center operations to focus on quality and resolutions, not quantity. In moving away from the "churn and burn" model, we've created a structure that empowers our call center teams to help members resolve their issues on the phone or, if a quick resolution isn't possible, set expectations about when we'll call them back. The proof is in the data. Our agent promoter scores (how likely an employee would be to recommend working at the company) comes in at 62. Far higher than industry standard.

Our in-house clinical care team is also an area where we've been able to design a people-first digital model. The team uses data to help us target the right members at the right time with support and resources fit for their needs. Take our COVID-19 response for example. As the pandemic ramped up, our claims and care management teams worked together closely to provide proactive and responsive support for both our clients and their members. Our outreach included calling members with conditions that put them at higher-risk to contract COVID-19 to advise them on their care plans, answer questions about safety and how to reduce their risk of exposure as much as possible. We were able to attribute this work to avoided admissions and healthier outcomes—all thanks t

Rethinking point of care diagnostics with symptom checkers

Technological innovation, as seen through the previous examples, can be critical not just in helping people have access to care, but to access higher quality care when they need it. Symptom checkers, which help patients identify their potential health conditions in advance of doctors appointments, help make the best possible use of doctors time and harness the latest research insights to provide high quality care, especially during the pandemic as health resources are diverted to caring for COVID patients, they have been vital in giving people timely health advice.

Symptom checkers thrive as a new entry door to medical guidance and reassurance in COVID times

By Andres Martin
Head of Health Services Innovation, AXA Next

Accessing quality and timely clinical guidance, especially for non-COVID health episodes, has not been easy during the COVID pandemic. Symptom Checkers are becoming part of the new normal for getting clinically validated advice about 'what to do next' when feeling unwell.

Many of us have felt unwell at least once over the last year. Depending on the symptoms suffered, one of the first questions that might have come to minds was 'will it be COVID?'. This thought was a scary one, doubly. Firstly, because we felt in need of an immediate reassuring response. And secondly, because during the hardest time of the COVID pandemic over the last twelve months, it was not easy to access the doctors and medical centres that would provide such guidance in a timely manner.

In this context, there has been a significant increase in the demand for accessing trusted clinical guidance here and now. And this is exactly what the solutions known as 'symptom checkers' offer, and the reason why millions of people are increasingly using this digital service around the world.

AXA Next and some AXA entities are deploying this new digital health solution to strengthen both the care coordination capabilities and the end-to-end health service delivery, which are crucial aspects to become a trusted healthcare partner to millions of people around the world.

The key drivers of adoption by users and doctors

Based on our own AXA research done in France in 2019, already 15% of people surveyed accessed symptom checkers instead of searching for their symptoms on Google. This is an increasing trend that COVID pandemic has strongly accelerated.

Most of these solutions have been developed in a consumer centric manner. They are very engaging and efficient in their AI led conversational assessment with the user. In average, they claim to get to a pre-diagnosis report in 3-4mins with an assessment completion rate of 80-90%.

This new generation of clinical decision engines mix traditional clinical evidence literature, data analytics and AI tech to offer re-assurance and guidance to users by:

- assessing the medical history and declared symptoms,
- providing an indicative list of most probable conditions (pre-diagnosis), and
- recommending the next step of care according to the most probable condition and to the case severity (triage and care coordination), e.g. "you need to see a doctor in the next 2-3 days, no urgent care is needed if the symptoms don't worsen"

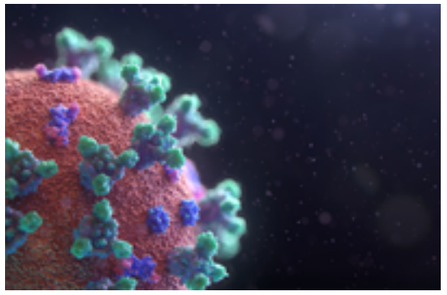
A recent study found out that symptom checkers, by providing real time clinically validated guidance, helped users reducing their own sense of urgency for their intended level of care in 25% of the cases (e.g. shifting from emergency room visit to teleconsultation).
Another key factor in the increasing acceptance of this new digital health service is that these solutions also enable users to book or have an appointment with a doctor in just one click (in person/remotely, now/later).

Additionally, the user can also choose to share the pre-diagnosis report with the doctor, which will provide the physician with a rich clinical context in a very efficient manner to focus the consultation time on the very relevant aspects.

One of the key players claim that their fully digital primary care model, which combines both AI symptom assessment and chat consultation with a doctor, leads to a successful completion of 75% of their medical cases. The remaining 25% are sent to in person or remote consultations (phone or video).

All of the above means that tangible benefits of this digital service are perceived by the customers and progressively by the doctors too. Healthcare professionals are starting to realise that these solutions are not aiming to replace them but, on the contrary, to help them making a better and faster informed decision. Doctors are increasingly trusting the accuracy, safety and richness of data these solutions provide them with.

As a result, world leading health institutions such as Mayo Clinic (US), Sutter Health (US), NHS (UK), Maccabi Health (Israel), are partnering with diverse providers of this new consumner and clinical technology to improve their service offering and data analytics.



Trusted guidance and care navigation is a priority for AXA

There are many insurers who are also integrating this kind of offering as an added value service to their customers, such as Bupa and Babylon (UK), Allianz Care and Infermedica (Germany), Mapfre/Savia and Mediktor (Spain), Anthem Blue Cross and K-Health (US), or Prudential and Babylon (Asia).

AXA is taking firm steps in this journey, in which several advanced entities are deploying exciting partnerships with key players such as in markets such as Hong Kong, Germany, Italy and Egypt. Other entities will join this list soon.

AXA Next's Health Service practice is fully focused on supporting AXA entities deploying and scaling new health business solutions in insurance, services and healthcare provision (vertical integration). This support is developed via expert resources and co-funding in order to accelerate the deployment and impact of improved customer experience and more effective care coordination.

AXA Next's work with some AXA entities in these new services for better care coordination aim to unlock key benefits such as the following:

- facilitating free access to quality guidance to customers and non-customers, promoting AXA as a health partner at scale in strategic markets
- accelerating the growth of teleconsultations (instead of in-person) when clinically indicated for both insured and out-of-pocket customers
- avoiding unnecessary consultations (with subsequent claims cost reduction)
- reducing unnecessary Emergency Room visits (which improves the customer experience)
- accessing to a rich new set of data that will helps us to better understand the needs of our customers and to better design our health service offering and clinical operations (physical and digital).

All of the above define AXA's high ambitions and determination to succeed in this dynamic space via diverse use cases, health services offering and partners across several markets.

Over the next few months AXA will start seeing the positive impact of such new digital offering on our customers' experience. Especially when accessing to quality clinical guidance and effective care coordination, which both have grown in importance during COVID, but that will for sure still remain as fundamental customer touch-points where AXA needs to excel once COVID pandemic fades away, hopefully very soon.

Applying technological innovations to insurance: a key lever for expanding healthcare access

Making insurance work better can be an important aspect of expanding access to care. As we will see with the application of blockchain technology gains in security and efficiency from this new way of sharing information have far reaching impacts and very concrete benefits for healthcare accessibility as seen through the Decent Health Plan case study. Enlarging our perspective even further, we will explore artificial intelligence and its incredible potential to automate many healthcare services.

Harnessing the benefits of blockchain technology to improve medicine and access to health insurance

Blockchain is a technology that appeared in 2008 with the introduction of Bitcoin. Its uses extend far beyond cryptocurrency with wide-ranging applications including in insurance, finance, and medicine.

To put it simply, a blockchain is a ledger that requires multiple parties to sign off on an entry. Once an entry is made, it cannot be undone without the rest of the ledger being undone, like a link in a chain. This mechanism enables parties who don't know or trust each other to trust in the record contained in the blockchain, removing the need for a central authority to validate facts stored in the blockchain. This secure record which does not require outside validation has the potential to transform many back-end operations which now require lengthy verification processes.

Making insurance more efficient and trustworthy

In insurance, block chain technology can be used to create smart contracts, which automatically pay claims in the event that conditions are met. It can also be used to improve operations. For health insurance specifically, it can be used as an information storage system that utilizes different hospital, patient, and insurance company servers that verify each other's activity and security[2]. Using blockchain in this way can provide greater transparency and trust between the different actors in the patient care journey.

The full promise of blockchain technology has yet to be seized, but its potential for both medicine and insurance are extremely significant. Secure data records that do not require a central authority for verification can pave the way not only for greater trust and efficiency gains, and give patients greater access and control over their medical data. The gains from blockchain's enhancement/ encourage of the use of technology and improvements in administrative processes, blockchain can be an important enabler in expanding healthcare access.

[2] Hannah S Chen,† Juliet T Jarrell,† Kristy A Carpenter, David S Cohen, and Xudong Huang - Blockchain in Healthcare: A Patient-Centered Model - Published online 2019 Aug 8 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6764776/

Case study: How Decent Health Management intends to use blockchain to make healthcare more accessible

Decent Health Management in the U.S. is a partner of AXA and shares its reflections on plans to make blockchain an integral part of its operations.

How do you plan to use blockchain?
In the short term we intend to use blockchain to incentivize our members to address health issues, schedule preventive medicine exams, and otherwise engage in their own health. Such as earning tokens for getting a flu shot. In the long term we believe that industries where the customers inherently do not trust the central body controlling the flow of funds - in this case health plans - are ripe for disruption by blockchain. Applicability in healthcare includes provider credentialing, claims processing, portable health records, and provider payments.

What are the benefits for insureds?
It is my hope that the experience for the insureds is seamless and they do not recognize the use of blockchain as the backbone of their experience. Our hope is that they interact with a token economy by earning tokens for taking care of themselves should and perhaps leveraging those tokens for rebates on health foods, or gym memberships, etc. The hope is that the experience of a decentralized administrator is that better decisions are made regarding claims payment as well as speed of payment to providers.

How does blockchain help you to achieve your vision of a world "where everyone has the freedom to do the work they want without sacrificing access to affordable and comprehensive healthcare"?
People want to know that their health record is secure and private. In addition there is so much about healthcare that is opaque. Blockchain is the embodiment of the things that healthcare administration lacks: privacy, unalterable ledger accounting, and transparency. In my mind, this is a puzzle piece that fits together so nicely to alleviate huge frustrations felt by consumers in healthcare.

How do you see blockchain changing the world of health insurance in the years to come?
Health plans can talk securely to providers, providers are paid promptly using smart contracts. Providers & health plans can easily communicate PHI or HIPAA protected data with patients securely using keys. The most wonderful thing would be if we could allow people to form their own risk pools and act as their own health plans with 100 of their closest friends. By decentralizing how we craft and administer risk the small groups can leverage advantages previously only held by large self-funded employers.

Applying technological innovations to medicine: enabling healthcare access through medical progress

While pioneering medical research takes place everyday with the potential to cure and keep people healthy, a few technological advancements are particularly well poised to expand healthcare access. Blockchain, seen earlier in the publication, has important medical applications. Artificial intelligence, particularly Machine Learning, are fundamental advancements that can expand capacity within health systems. By making medicine more productive and efficient, more people can be treated for the same or lesser cost through automation. When looking at how to expand access to healthcare, focusing on the medical part of the equation is critical.

Blockchains in medicine: an enabler for innovation and efficiency

To learn more about blockchains, see page 16

Beyond their insurance applications, blockchains can be used to create secure patient data records and share them. They can also be used to track the authenticity of medications, safely store patient data, and automate administrative processes.[3]

A major issue in the use of data for patient care has been the question of who can control access to the data, and ensuring its security. Blockchain technology can enable patients to have control of their data and who accesses it, and the nature of blockchain technology makes it secure.[4] This can encourage the use of mobile health applications which use blockchain to store data, with the patient as the owner of the blockchain and able to share it with their providers.[5] Mobile healthcare can be a key factor in making care more accessible, and the security of blockchain technology can encourage its use.

Blockchain can also be applied to patient medical records, which are often stored in multiple healthcare facilities. In contrast to the current system, blockchain technology can be used to give patients control over their records so they can have access to all their information in one place and share it securely.[6] Blockchain technology has also been applied to clinical trials and can be used to ensure that data in a clinical trial is truthful, and enable secure data sharing between researchers.[7]

[3] Built in- 15 EXAMPLES OF HOW BLOCKCHAIN IS REVIVING HEALTHCARE - https://builtin.com/blockchain/blockchain-healthcare-applications-companies- Sam Daley July 1, 2019 Updated: March 25, 2020

[4] Hannah S Chen,† Juliet T Jarrell,† Kristy A Carpenter, David S Cohen, and Xudong Huang - Blockchain in Healthcare: A Patient-Centered Model - Published online 2019 Aug 8 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6764776/

[5] Hannah S Chen,† Juliet T Jarrell,† Kristy A Carpenter, David S Cohen, and Xudong Huang - Blockchain in Healthcare: A Patient-Centered Model - Published online 2019 Aug 8 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6764776/

[6] Hannah S Chen,† Juliet T Jarrell,† Kristy A Carpenter, David S Cohen, and Xudong Huang - Blockchain in Healthcare: A Patient-Centered Model - Published online 2019 Aug 8 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6764776/

[7] Hannah S Chen,† Juliet T Jarrell,† Kristy A Carpenter, David S Cohen, and Xudong Huang - Blockchain in Healthcare: A Patient-Centered Model - Published online 2019 Aug 8 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6764776/

[8] OECD (2020), The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector, www.oecd.org/finance/Impact-Big-Data-AI-in-the-Insurance-Sector.htm.

Artificial Intelligence: medical applications with the potential to change healthcare systems

Artificial intelligence (AI) is an umbrella term for computer systems that have the capacity to learn, adapt and operate in dynamic and uncertain environments by mimicking human cognitive functions. Machine learning is a branch of artificial intelligence that allows computers to program themselves and detect patterns in large datasets. This technique allows computers to process large amounts of data and detect patterns in an iterative fashion with limited human intervention. If you have used an application that helps detect a plant or animal species using an image, you have been exposed to machine learning, which is more and more common in everyday applications.

AXA Research Fund grantees Thomas Lukasiewicz, Artificial Intelligence Chair, and Santiago Mazuelas explain how these powerful technologies are important enablers for healthcare access.

Explaining Artificial Intelligence - a key enabler for using Artificial Intelligence in healthcare and so expanding healthcare access:

By Thomas Lukasiewicz
AXA Research Fund Chair for Artificial Intelligence and Oxford University, Professor of Computer Science

Artificial intelligence (AI) holds great promise as a way to expand healthcare capacity and improve medical outcomes. It can also help predict and reduce risks. Through better medical outcomes, the potential for more effective use of healthcare resources, and greater understanding of healthcare risks, the benefits of AI can be harnessed to expand healthcare access.

Medical innovation powered by AI

Progress in AI with applications for healthcare began to appear around 2017, when a system was developed that was able to detect skin cancer with the same level of accuracy shown by human experts in the field. Looking more closely at skin cancer detection, we can get an idea of where this progress could take us. There are now research prototypes that are better than human experts at detecting skin cancer. In fact, there are already apps that you can download on your smartphone and use to detect changes in your skin, whether they are skin cancer or not. Obviously, no one should forego expert advice, but these systems are getting better and better. A number of other milestones have been reached in healthcare. For example, prostate cancer grading by AI is better than human experts, and in 2018, AI systems became better than humans at predicting the 3D structure of proteins. In 2019, they surpassed humans at detecting diabetes-related illnesses in the eye.

The importance of explainability

Despite these advances, being able to explain how they work is a very significant drawback in using neural networks, the technology underlying the current wave of AI systems. Neural networks are extremely powerful, but they are black boxes that turn an input into an output, and we are not able to explain how they work. If we want to make a diagnosis from structured data from the symptoms that a patient has, then we may just return the symptoms that were relevant for the decision as explanation. For example, the diagnosis is flu, and the system may return that the patient was sneezing, had a headache but had no fatigue. So, that could be returned as an explanation. But there is still no guarantee that the data that is shown is used in a correct way to calculate the outcome. These obstacles are especially valid for healthcare. An incorrect diagnosis of a disease may lead to an incorrect treatment with life-threatening consequences for the patient. We would like this black box of the neural networks to be explained in such a way that we know that the output is calculated in a correct way from the input.

A way forward for AI healthcare applications

In my AXA Research Fund project, I am building neural-symbolic AI systems that will help us to produce better and less expensive diagnoses, optimize and personalize the treatment of patients, and also prevent diseases by collecting and using live data from humans (for example, via wearables) and then predicting the lifestyle and potential risks of these people. This in turn will substantially reduce healthcare costs while improving healthcare availability and reducing mortality and morbidity. We can obtain a more accurate risk prediction, concerning both lifestyle and treatments, and we can also act to reduce our risk. As a side effect of explainability, I also hope to improve the medical understanding of diseases and treatments.

The potential of AI for disease prevention, early detection of diseases, better and more affordable diagnosis, and medical decision making in general to designing new pharmaceutical products and optimized treatments can help make healthcare more effective, and also more affordable. Through the use of AI, greater overall medical capacity is available, creating a pathway for expanding healthcare access. For the insurance industry, these benefits will also allow for a more accurate health risk prediction and the possibility for risk reduction- a win/win to create a healthier society.

Machine Learning to predict health outcomes: allocating resources in healthcare systems

During the COVID-19 pandemic, machine learning was harnessed to help predict health outcomes. For a disease whose symptoms ranged from severe breathing problems and even death to asymptomatic infections, machine learning provides a valuable tool to best anticipate the health needs of a population and prescribe the best care for individual patients. Deployed at a wide scale, this technology can help healthcare systems better allocate their resources, which can be leveraged to increase access. AXA Research Fund grantee Santiago Mazuelas explains how he used this technology to help predict the severity of COVID-19 diagnosed patients.

Early Prognosis of COVID-19 Infections Via Machine Learning

Principal investigator:
Santiago Mazuelas, Ramon y Cajal Researcher
Institution:
Basque Center for Applied Mathematics (BCAM)

Differently from other diseases, COVID-19 infections result in particularly distinct outcomes: certain patients remain asymptomatic during the infection, some other experience moderate symptoms for a few weeks, and yet others suffer acute or even critical complications. Wrong assignments of care's type for COVID-19 patients may cause fatal outcomes, and lack of isolation measures for asymptomatic infections may increase COVID-19 propagation among the population. These facts pose a key challenge for COVID-19 containment since the most pertinent countermeasures at the time of infection's detection are markedly different for each type of patients.

The project "Early Prognosis of COVID-19 Infections Via Machine Learning" develops machine learning techniques for the early prognosis of COVID-19 infections that predict infections' future severity using health data obtained soon after the detection. This project has been funded by the AXA Research Fund under the Exceptional Flash Call "Mitigating risk in the wake of the COVID-19 pandemic" and is being carried out at the Basque Center for Applied Mathematics (BCAM) from October 2020 to October 2023.

The algorithms developed in the project can be used by medical personnel or public health stakeholders to take timely decisions that result in favorable outcomes. For instance, an infected patient with a negative early prognosis who is predicted to have a positive response to treatment can be directly transferred to semi-intensive care before he/she undergoes notable symptoms.

In addition, the prediction algorithms developed in the project can also be used to closely monitor noninfected individuals with high probabilities of being asymptomatic or suffer complications in case they become positive for COVID-19.

The techniques developed in the project utilize multimodal and information-rich health data to predict the future severity of COVID-19 infections. This health data is composed by clinical data such as age, sex, weight, blood pressure, body temperature, heart rate, respiratory rate, and past medical history (PMH), together with more detailed metrics such as those obtained from biochemical tests. The learning techniques developed in the project use a large amount of electronic health records to learn the complex relationship between health data instances and COVID-19 severity. The project will address several scientific and technical challenges both for data processing and learning algorithms' design including the usage of unbalanced training samples affected by selection bias, and the development of cost-sensitive techniques.

One of our first developed algorithms is able to predict the risk of a fatal outcome when a new COVID-19 patient is admitted to the hospital with a 90% sensitivity (true positive rate) and 75% specificity (true negative rate). Algorithms like this one are designed to become a key aid for healthcare providers when assessing incoming patients.

In addition to the prognostic component, machine learning based algorithms can also provide new working hypothesis on the pathogenesis of COVID-19. One example for us is the inclusion of various eosinophil blood markers (variety of white blood cell markers) as relevant predictors, unveiling the importance of these particular white blood cells in the protection against the SARS-CoV-2 infection. Several teams of researchers across the world are pursuing similar endeavors, with the hope that soon we could all exploit data from multiple countries and continents allowing the creation of more accurate and precise prognostic tools for COVID-19.

The machine learning techniques developed in this project can enable remarkable improvements in the way healthcare systems operate. In particular, they can serve to improve they way in which medical and public health decisions are taken to treat and manage COVID-19 infections. In addition, the learning algorithms developed in the project can also enable healthcare systems to better categorize risks of individuals. More broadly, the learning methodologies developed in the project can be leveraged to develop machine learning methods that assess the likelihood of future adverse general events based on data obtained ahead of time.

Conclusion

Expanding access to healthcare can happen through many kinds of innovation. Point of care innovations are very powerful in making healthcare available to more people. Fully digital customer experiences, such as Maestro Health's services, make healthcare more efficient and scalable. AXA Next's symptom checkers change patient experience and improve not only how the time is spent when they see doctors to focus on what can't be done at a distance, but also enhance the capacity of doctors to diagnose them by making the latest scientific research available. On the insurance side, blockchain technology is unleashing important efficiency gains and making healthcare more customer-centric. Decent Health shows concretely how blockchain can be leveraged to expand healthcare access. In medicine, great potential lies in blockchain but especially in artificial intelligence to completely change how medicine is conducted. The ability to automate tasks such as cancer diagnosis which previously could only be done by highly trained specialists can make healthcare much more efficient and affordable and ultimately accessible. Machine learning and its predictive power can be deployed to not only use prediction to treat patients more effectively, as was done in Santiago Mazuelas' research on COVID-19 severity, but also to change the way resources are allocated in healthcare systems for greater efficiency.

Our creativity is needed on all sides of the healthcare equation- point of care, insurance, and medicine- to expand access. With the scalable advancements described in these pages, an abundance of healthcare resources can be unlocked to expand access to care.

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